# Partial Replacement of Sand by Quarry Dust in Concrete

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***Abstract-*** The paper describe the role of quarry dust In the construction of buildings and other structures to eliminate the demand of natural sand by using quarry waste to replace the use of natural sand. We are investigating the potential of using quarry waste and its effect on the strength and workability of concrete. This paper reports the experimental study which investigated the partial replacement of sand with quarry dust. Initially cement concrete cube was studied with various proportions of cement concrete + quarry dust (M 20, AND M25). The experimental results showed that the addition of quarry dust as fine aggregate ratio of 30%, 40% and 50% was found to enhance the compressive properties.

***Index Terms***- Sand, flash, quarry dust (QD), sieve analysis, slum cone test. Compressive test

## I. INTRODUCTION

Some developing countries are facing a shortage in the supply of natural sand. The expertise of construction industries is investigating the other alternatives to eliminate the demand of natural sand. There were some alternatives that have been used in concrete mixing such as fly ash, slag and limestone.

Another alternative is by using quarry waste to replace the use of natural sand. Quarry dust can be defined as residue, tailing or other non-voluble waste material after the extraction and processing of rocks to form fine particles less than 6mm. Natural sand in many parts of the country is not graded properly and has excessive silt. On the other hand, quarry dust does not contain silt or organic impurities and can be produce to meet desired gradation and fineness as per requirement. Consequently, it improves the strength of concrete. Besides, waste can be used to produce new products or can be used as admixtures so that natural sources are used more efficiency and environment is protected from waste deposits.

## II. PROPOSED METHODOLOGY

**Material used**

**SAND: Sand** aggregates accounts for at least 75% of the volume of masonry mortar and grout. Manufactured sands have sharp, angular grains, while natural sands obtained from banks, pits and river beds have particles that are smooth and more rounds

**CEMENT:** Portland cement has become the most widely used material of its kind. Portland cement is a carefully controlled combination of lime, silica, alumina and iron oxide. When mixed with water, Portland cement undergoes hydration-a change in the chemical composition of the ingredients in crystals of various complex silicates are formed, causing the mass to harden and set.

**AGGREGATES:** Aggregates are important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy.

**QUARRY DUST:** Crushed rock aggregate quarrying generates considerable volumes of quarry fines, often termed “quarry dust”. Quarry dust can be defined as residue, tailing or other non-voluble waste material after the extraction and processing of rocks to form fine particles less than 4.75mm.

**Test on Materials**

**Test on Aggregate and Sand**

1. Sieve Analysis (Fineness Modulus)
2. Specific Gravity

**Sieve Analysis:** This is the name given to the operation of dividing a sample of aggregate into various fractions each consisting of particles of the same size. The sieve analysis is conducted to determine the particle size distribution in a sample of sand or aggregate, which we call gradation.

**Specific Gravity:** Specific gravity of aggregates is made use of in the design calculations of concrete mixes. With the specific gravity of each constituent known, its weight can be converted into solid volume and hence a theoretical yield of concrete per unit volume can be calculated. Specific gravity of aggregate is also required in calculating the compacting factor in connection with the workability measurements.. Average specific gravity of the rocks varies from 2.6 to 2.8

**Test on Cement: Normal Consistency**: For finding out initial setting time, final setting time and soundness of cement, and strength a parameter known as standard consistency has to be used.

**Test on Concrete**

**Slump Cone Test:** The concrete slump test is an empirical test that measures the workability of fresh concrete. More specifically, it measures the consistency of the concrete in that specific batch. This test is performed to check the consistency of freshly made concrete. Consistency is a term very closely related to workability

**Compression Test:**

This test is most common but important test conducted on Hardened concrete. The test is easy to perform and the most desirable characteristic of concrete are qualitatively related to its compression test.

The compression test is carried out on cubical specimen; the cube specimen is of size 150mm×150mm×150mm. The aggregate size of 20mm will be used to make concrete mixes.

This test will be done for conducted for concrete cubes of 30% then 40% and 50% replacement of sand by Quarry dust for M20 and M25 mixes.

## III. SIMULATION/EXPERIMENTAL RESULTS

**TABLE 1. RESULT OF SIEVE ANALYSIS FOR SAND**

| IS Sieve Size | Wt. Retained (gm) | Cumulative wt. retained (gm) | Cumulative % wt. retained | Cumulative % passing |
|---|---|---|---|---|
| 10mm | 0 | 0 | 0 | 100 |
| 4.75mm | 10 | 10 | 2 | 98 |
| 2.36mm | 50 | 60 | 12 | 88 |
| 1.18mm | 50 | 110 | 22 | 78 |
| 600µ | 95 | 205 | 41 | 59 |
| 300µ | 175 | 380 | 76 | 24 |
| 150µ | 85 | 465 | 93 | 7 |
| <150µ | 35 | 500 | | |
| Total | 500 | | 246 | |
| **F.M.= 246/100 = 2.46** | | | | |

**TABLE 2: RESULT FOR SPECIFIC GRAVITY OF SAND**

| SR. NO. | W1(GM) | W2(GM) | W3(GM) | W4(GM) | G($M/S^2$ EC) | $G_{AVG}$($M/S^2$ EC) |
|---|---|---|---|---|---|---|
| 1 | 650 | 1422 | 2006 | 1518 | 2.72 | 2.51 |
| 2 | 650 | 1552 | 2087 | 1550 | 2.47 | |
| 3 | 625.5 | 1459.7 | 2004.2 | 1515.5 | 2.41 | |

**TABLE 3: RESULT FOR NORMAL CONSISTENCY OF CEMENT**

| SR. NO. | PERCENTAGE OF WATER | PENETRATION(MM) |
|---|---|---|
| 1 | 26% | 36 |
| 2 | 27% | 9 |
| 3 | 27.5% | 6 |
| NORMAL CONSISTENCY=27.5% | | |

**TABLE 4: RESULTS FOR SLUMP CONE TEST FOR QUARRY DUST MIX CONCRETE**

| GRADE OF CONCRETE | AMOUNT OF QUARRY DUST | SLUMP VALUE(CM) |
|---|---|---|
| M20 | 30% | 9 |
| | 40% | 10 |
| | 50% | 15 |
| M25 | 30% | 10 |
| | 40% | 11 |
| | 50% | 13 |

**TABLE 5: Results for Compressive Strength Test for Quarry Dust mix Concrete (7 Days)**

| Grade of Concrete | Amount of Q.D. | W/C Ratio | Hydraulic Force (KN) | Compressive Strength ($N/mm^2$) |
|---|---|---|---|---|
| M20 (1 :1.5: 3 ) | 30% | 0.7 | 221.69 | 9.85 |
| | | | 220.5 | 9.8 |
| | | | 222.56 | 9.89 |
| | 40% | 0.7 | 172.3 | 7.66 |
| | | | 169.12 | 7.52 |
| | | | 173.86 | 7.73 |
| | 50% | 0.7 | 200.65 | 8.92 |
| | | | 199.13 | 8.85 |
| | | | 189.54 | 8.42 |
| M25 (1:1:2) | 30% | 0.7 | 191.74 | 8.52 |
| | | | 177 | 7.86 |
| | | | 187.96 | 8.35 |
| | 40% | 0.7 | 160.2 | 7.12 |
| | | | 177 | 7.86 |
| | | | 181.14 | 8.05 |
| | 50% | 0.7 | 222.71 | 9.89 |
| | | | 182.89 | 8.12 |
| | | | 192.54 | 8.56 |

**TABLE 6:.Results for Compressive Strength Test for Quarry Dust mix Concrete (28 Days)**

| Grade of Concrete | Amount of Q.D. | W/C Ratio | Hydraulic Force(KN) | Compressive Strength ($N/mm^2$) |
|---|---|---|---|---|
| M20 (1 :1.5: 3 ) | 30% | 0.7 | 399.19 | 17.74 |
| | | | 401.23 | 17.83 |
| | | | 412.84 | 18.35 |
| | 40% | 0.7 | 421.12 | 18.72 |
| | | | 424.01 | 18.84 |
| | | | 404.1 | 17.96 |
| | 50% | 0.7 | 430.2 | 19.1 |
| | | | 428.31 | 19.04 |
| | | | 418.24 | 18.6 |
| M25 (1:1:2) | 30% | 0.7 | 512.8 | 22.8 |
| | | | 510.43 | 22.7 |
| | | | 515.55 | 22.91 |
| | 40% | 0.7 | 531.41 | 23.62 |
| | | | 523.04 | 23.25 |
| | | | 520.32 | 23.13 |
| | 50% | 0.7 | 551.1 | 24.5 |
| | | | 541.45 | 24.06 |
| | | | 536.21 | 23.83 |

**Chart no. 1**

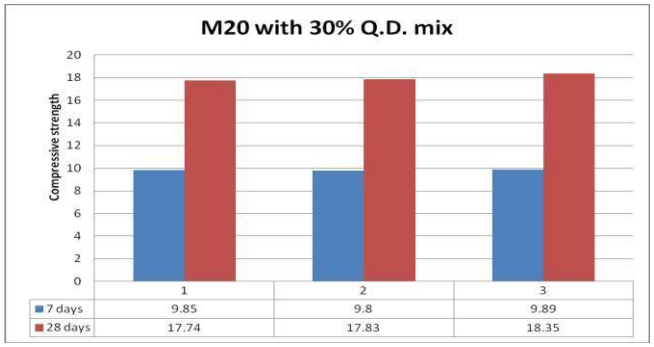
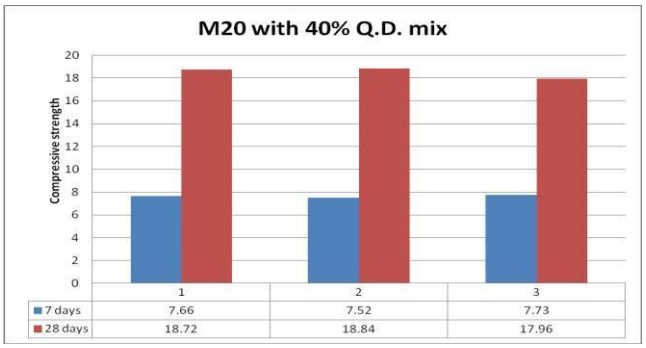



**Chart no. 2**

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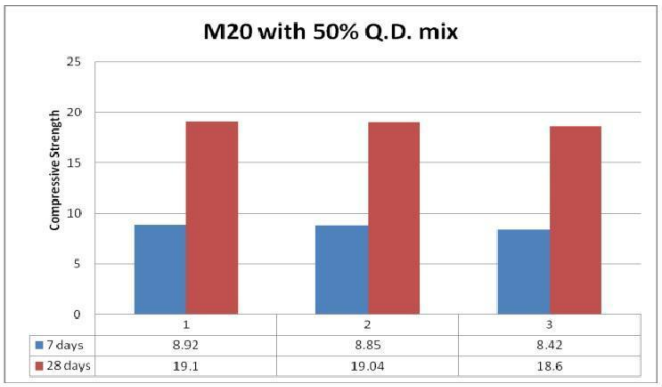


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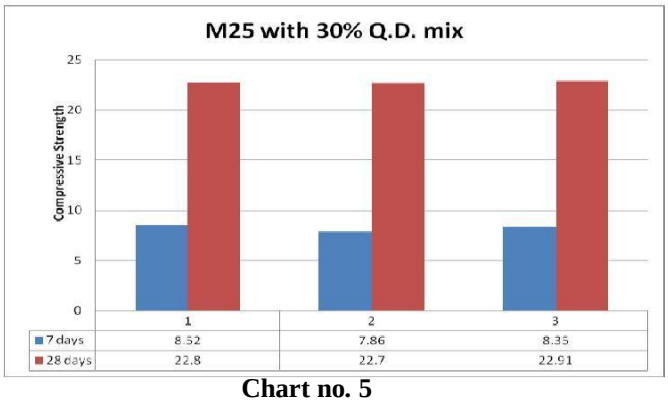


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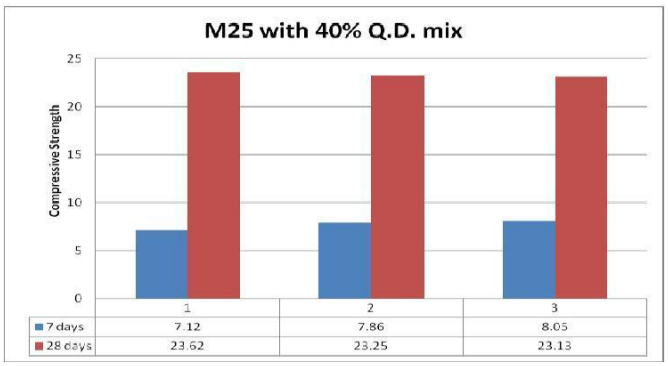


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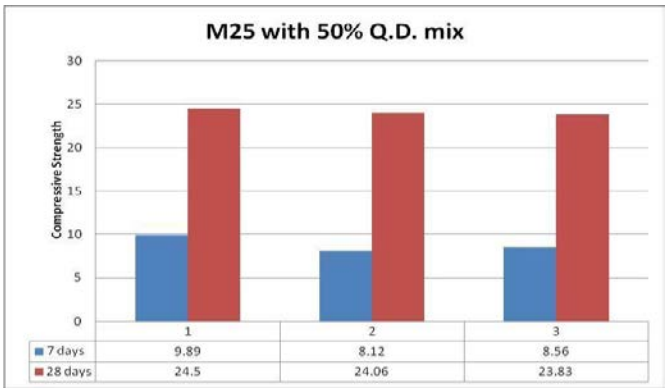

## IV. CONCLUSION

Based on the results and discussion mentioned above, the following conclusions are obtained:

1. Mix ratio of 1:1.5:3 (cement: aggregate: sand+ quarry dust) give the optimum strength in this study. (refer Table 6,7)
2. As the percentage of Quarry Dust gradually increases, the Compressive strength of concrete will also increase with condition that percentage of Quarry Dust should not exceed 50%.
3. The compressive strength of compressed concrete increase with the increase of age of maturity. The value of strength for 28 days higher than the strength for 7 days. (refer Table6,7)
4. According to the value of compressive strength collected, the value is high and it show that quarry dust suitable to use as sand replacement. All the value of compressive strength surpasses the minimum value of compressive strength for normal concrete that is 7N/mm . So, quarry dust can apply as sand replacement in concrete mix for construction industry.

## V. FUTURE SCOPES

According to the value of compressive strength collected, the value is high and it show that quarry dust suitable to use as sand replacement The industrial waste or by product from crushing & construction company i.e. Quarry Dust can be well utilized. The utilization of Quarry dust as a partial replacement of sand in concrete can reduce the cost of construction.

## REFERENCES

[1] CHARACTERISTICS STUDIES ON THE MECHANICAL PROPERIES OF QUARRY DUST ADDITION IN CONVENTIONAL CONCRETE BY A. SIVAKUMAR AND PRAKASH M. (DEPARTMENT OF CIVIL ENGINEERING, VELLORE INSTITUTE OF TECHNOLOGY (VIT) UNIVERSITY, INDIA.)

[2] FLEXURAL AND TENSILE STRENGTH PROPERTIES OF CONCRETE USING LATERITIC SAND AND QUARRY DUST AS FINE AGGREGATE

[3] BY JOSEPH. O. UKPATA1 AND MAURICE. E. EPHRAIM2 (1.DEPARTMENT OF CIVIL ENGINEERING, CROSS RIVER

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[5] STRENGTH AND DURABILITY PROPERTIES OF CONCRETE CONTAINING QUARRY ROCK DUST AS FINE AGGREGATE BY R. ILANGOVANA, N. MAHENDRANA AND K. NAGAMANIB (DEPARTMENT OF CIVIL ENGINEERING, PSNA COLLEGE OF ENGINEERING, DINDIGUL, INDIA) (DEPARTMENT OF CIVIL ENGINEERING, COLLEGE OF ENGINEERING ,GUINDY , ANNA UNIVERSITY, CHENNAI. INDIA)

[6] TEXT BOOK OF CONCRETE TECHNOLOGY OF M.S. SHETTY.

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